Impermeable thin Al_2O_3 overlay for TBC protection from sulfate and vanadate attack in gas turbines

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Current advanced turbine system (ATS) requires thermal barrier coatings (TBCs) on turbine blades and vanes. The TBCs being specified, based on yttria stabilized zirconia (YSZ), have the limited durability for advanced industrial gas turbine applications that have longer durability requirements (30,000 hours versus <10,000 hours), particularly when dirty fuels are burned. Surface deposits (including molten sulfate and vanadate salts) can penetrate into porous TBCs and result in hot corrosion, leading to premature spalling.

In the present project, it is planed to deposit a dense overlay Al_2O_3 on the surface of the YSZ coating to prevent YSZ coating from hot corrosion of deposits derived from combustion of low-grade fuel and air impurities. The dense overlay Al_2O_3 acts as a barrier to protect TBC and bond coat. The overlay Al_2O_3 will be deposited on the surface of the thermal barrier coating using physical vapor deposition (PVD) technique and sol-gel method, respectively. The hot corrosion resistance of the composite Al_2O_3/YSZ coating will be evaluated. The hot corrosion behavior of the Al_2O_3/YSZ/NiCrAlY/superalloy system will be compared with the YSZ/NiCrAlY/superalloy system. The corrosion behavior of the sol-gel–modified Al_2O_3/YSZ system will also be compared with that of the PVD-treated system. The mechanism of hot corrosion will be investigated. The processing-structure-properties relationship of the overlays will be determined.

The implementation of the TBC technology is to improve the durability of turbine components and allow the service of turbines in fuels with impurity, which will contribute to the missions and goals of the DOE "Vision 21" R&D program in advanced materials, energy efficiency, environment stewardship and energy production.